NASA's Digital Learning Network and the Scientific Method:

Active Learning in Synchronous Distance Learning

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Introduction

Distance learning is one of the fastest growing trends in educational uses of technology. Instructors familiar with the pedagogical methods of face-to-face instruction have found themselves in a brand new technological world, so there is a need for guidance in engaging students in distance learning environments. Instructional techniques in one format of distance learning, asynchronous, have been studied and well documented in research. However, research in teaching methods for the second form of distance learning – synchronous – is lacking.

NASA's Digital Learning Network, or DLN, provides high quality interactive educational content through synchronous distance learning technologies. Over 40 lessons are offered to grades Kindergarten through 12th grades, addressing science, technology, engineering, mathematics, reading, and other content areas. Much like any other synchronous distance learning classroom, the DLN experiences issues in student engagement, content retention and understanding, and overall student satisfaction with their lessons. Upon researching effective strategies in the face-to-face classroom that address those three concerns, it was discovered that active learning strategies may translate well to the synchronous distance learning environment. For this project, the active learning strategies of "think-pair-share", individual writing, and group discussions were interspersed in the DLN lesson, "The Scientific Method: An Investigation of Impact Craters".

The project illustrates the following action research model (see Figure 1):

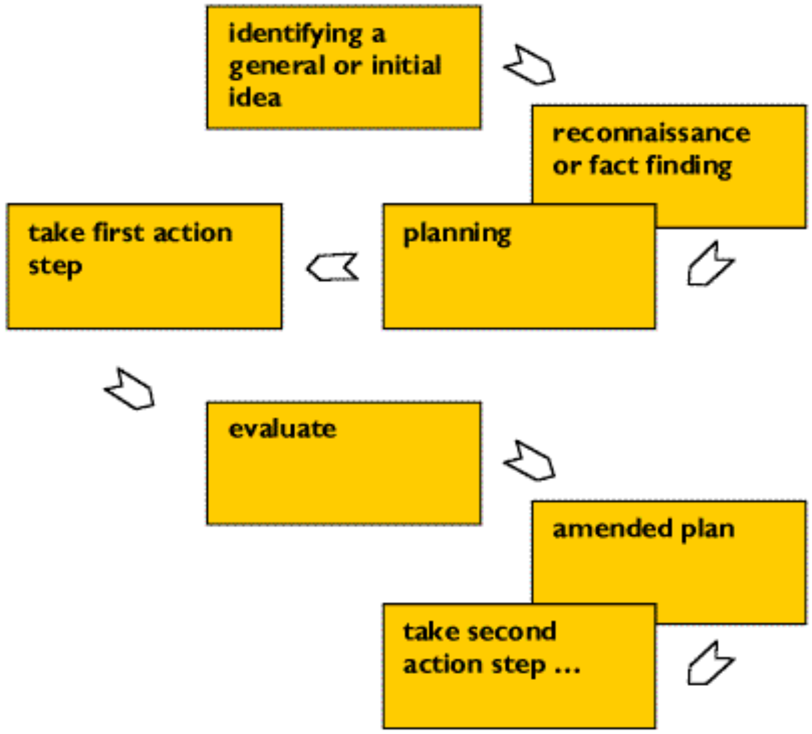

Figure 1. Lewin's Action Research Spiral (Smith, 2001)

Kurt Lewin – who is credited with coining the phrase "action research" – describes his approach as a spiral of steps that incorporates planning, action, and fact-finding as a result of the action. In the first step, a general idea is identified, and is followed by fact-finding or research on the initial idea. Out of this initial fact-finding session, a plan emerges on how to approach the situation in question. The plan is executed, and the results are examined. The results of the first action step lead to the next stage of the cyclical process.

In the following action research project, the following parts will be presented: area of focus, research questions, review of related literature, intervention/innovation, membership of the action research group, negotiations to be undertaken, timeline, data collection and analysis, findings, action planning, and

references. An appendix containing examples referred in the action research will be located at the end.

By following these steps, this project will examine a teaching method recommended for a face-to-face classroom setting with the anticipation of identifying an effective teaching method for the synchronous distance learning classroom.

Area of Focus Statement

The purpose of this study is to identify effective teaching methods for synchronous distance learning classrooms that are current recommended best practices in face-to-face classrooms. There are studies on how certain teaching methods in the face-to-face classroom address specific learning preferences, but these learning preferences may not thrive in classes at a distance due to the remote location of the teacher in synchronous distance education. Similar to a face-to-face class, it is the teacher's responsibility to deliver a distance education class that promotes effective learning amongst students. In this study, active learning will be applied to synchronous distance learning content. Given the similarities between presenting in a face-to-face classroom and a synchronous distance learning classroom, it is believed that this pedagogical strategy will work well in presenting science content for NASA's Digital Learning Network.

Research Question

How will the active learning model, a recommended best practice for teaching STEM education, work in delivering science content to 4th graders in a synchronous distance learning class?

Subquestion A: How will using the active learning model affect the knowledge retention of science content with 4th grade students?

Subquestion B: How will using the active learning model address misconceptions and gaps in 4th grade students' understanding of science content?

Subquestion C: How will the active learning model increase student engagement during the synchronous distance learning class?

Review of Related Literature

Distance learning is one of the fastest growing trends in educational uses of technology (Abrego Jr & Pankake, 2010; Dixson, 2010; Natriello, 2005). The innovation is seen as both effective in delivering educational content and its capability to offer students access to higher education outside of the traditional classroom (Butner, Murray, & Smith, 1999). Instructors familiar with the pedagogical methods of face-to-face instruction have found themselves in a brand new technological world, so there is a need for guidance in engaging students in distance learning environments. Instructional techniques in one format of distance learning, asynchronous, have been studied and are well documented in research. However, research in teaching methods for the second form of distance

learning – synchronous – is lacking. DiPietro, Ferdig, Black, and Preston (2008) best summarize the need for research in synchronous distance learning: “exploring this area is not only valuable in understanding instructional practice … but also for identifying the best practices …” (p. 12). This review of the literature will define asynchronous and synchronous distance learning, outline the important role student engagement and learner motivation poses in distance learning environments, and identify an effective teaching method for synchronous environments.

Distance Learning and Student Engagement

Distance learning can be delivered in two formats: asynchronous and synchronous. The synchronous model of distance learning permits a teacher and student to communicate in real time through difference spaces, while the asynchronous model allows instructors and students to interact at different times (Karal, Cebi, & Turgut, 2011). Research has proven that course content delivered via distance learning may be as effective or more so than traditional classroom delivery (Maki, Maki, Patterson, & Whittaker, 2000; Parker & Gemino, 2001). However, many students and researchers comment that distance learning courses lack interaction (McBrien, Jones, & Cheng, 2009). In order to provide effective online learning experiences, studies have examined how pedagogy effectively engages students.

Dixson (2010) states that research in effective online instruction offers several conclusions, one of which emphasizes strong instructor presence. Social presence of the instructor is defined in research as visible activity in a variety of

forms of communication (Kehrwald, 2008). In both models of distance learning, communication is viewed to be an integral component to effective online instruction (Cunningham, Fagersten, & Holmsten, 2010; Hill, 2010; Kehrwald, 2008). According to Azaiza (2011), when a student is able to communicate with the instructor, "this relationship is the best way to motivate learners and to increase their learning outcomes" (p. 25).

Multiple opportunities for communication may be more important than any particular channel (Dixson, 2010). In asynchronous classes, communication can be in the form of emails, chats, and discussion forums. Research stresses the importance for instructors in asynchronous environments to provide effective and frequent feedback to their students (Hill, 2010). Furthermore, Wickersham and McGee (2008) recommend:

> Instructor behavior requires that the instructor is responsive to learner needs, instruction is of the highest possible quality … feedback is provided in a timely manner, the instructor provides positive feedback, and the pace and flow of discussions is responsive to learners and productive in their achievement of course objectives. (p. 75)

Although distance learning at the K-12 level has grown in popularity, Cavanaugh, Gillan, Kromrey, Hess, and Bloymeyer (2004) observe "research-based investigations into the teaching and learning process in this medium and at this level are lacking" (DiPietro et al., 2008, p. 10). Best practices in asynchronous environments have been studied thoroughly while synchronous distance learning

has been nearly ignored. This poses an interesting conflict: research in student preferences reveals that synchronous environments are preferred because the social presence of the instructor is tangible and the sessions are interactive (Hill, 2010).

Synchronous distance learning, such as video conferencing-based technologies, creates a strong network bond, and enriches the communication and social interaction between instructors and students (Ahern, 2008,; Azaiza, 2011; Karal et al., 2011; King & Ellis 2009; McBrien et al., 2009;). This supports the research on the relationship between learners with fellow learners and instructors and learning motivation (Azaira, 2011; Coppola, 2002). Students in asynchronous courses can find themselves uncomfortable with the remote format, delayed feedback, and lack of face-to-face format, causing a decreased level of student interest and engagement (Karal et al., 2011; Owens, Hardcastle, & Richardson, 2009). Synchronous distance learning is considered more advantageous in terms of real time discussion and brainstorming, offering an environment similar to the face-to-face classroom and allowing instant feedback (Karal et al., 2011).

Why is there such a variance in understanding effective instructional practice in synchronous distance learning? The answer may lie in the similarity between face-to-face and synchronous learning. Instructors may equate synchronous environments such as video conferencing as another form of face-to-face instruction, unaware that the human interaction is not as effective as in the traditional education process (Karal et al., 2011). Although communication plays an integral role in

effective teaching, good instructional practice in face-to-face settings does not always translate to good teaching in distance learning settings (Davis & Roblyer, 2005).

Russell (2004) explains the skills needed for teaching in a distance learning environment "support a teacher's function as a point of intersection for technology, pedagogy, and content knowledge" (DiPietro et al., 2008, p. 11). Since synchronous distance learning requires a deep knowledge of both pedagogy, content, and technology integration, it is important to identify the appropriate methods for effective instruction in this environment (DiPietro et al., 2008). One such method to examine for synchronous distance learning would be active learning.

Active Learning

As recommended by the National Science Foundation's report *Shaping the Future*, "education [needs to] create a climate of engagement" (Smith, Douglas, & Cox, 2009, p. 20). As stated earlier, student engagement in distance learning is essential for effective learning. A possible best practice for synchronous distance learning that encourages student engagement may be an approach used in the face-to-face classroom and asynchronous distance learning classroom: active learning. This model is praised as a best practice for both science, technology, engineering, and mathematics, or STEM, education (Smith et al., 2009), as well as asynchronous distance learning (Dixson, 2010).

Active learning is generally defined as any instructional method that engages students in the learning process through meaningful activities while reflecting upon what they are doing (Prince, 2004). Activities in this model can range from "think-

pair-share" partner discussions, small group discussions, writing exercises, or brief demonstrations (Bonwell & Eison, 1991; Smith, 1996). Active learning techniques are typically used to focus student discussions and provide opportunities for practice of higher order thinking skills such as synthesis and analysis (Smith & Cardaciotto, 2011; Smith et al., 2009). For example, a lecture can be interspersed with opportunities for students to discuss and process what they are learning, while the bookends promote instructor-student communication to clarify any misconceptions on the content (see Figure 2).

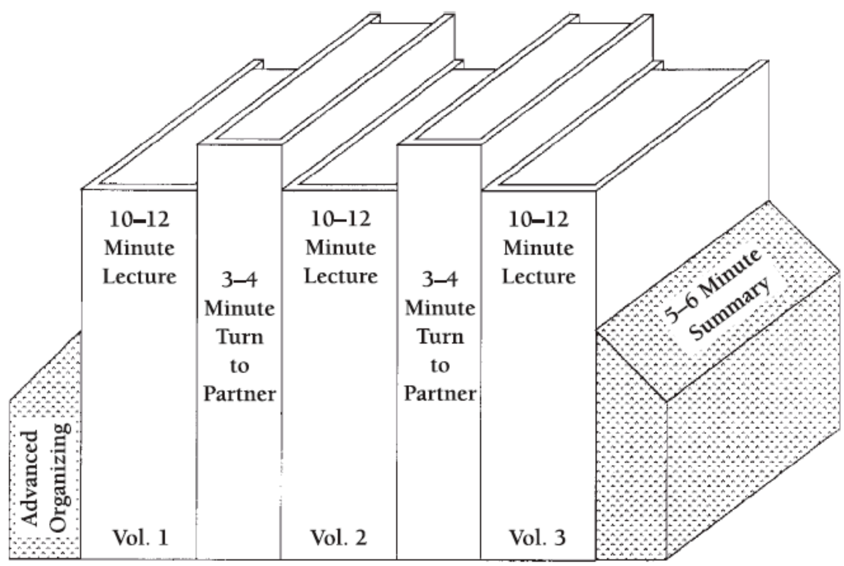

Figure 2. Bookends on a Class Session (Smith et al., 2009)

Reseachers have found that quality instruction in any setting includes opportunities for students to interact and process knowledge amongst themselves (Nichols, 2010), and "that rapport and collaboration between students, thought provoking questions, and dynamic interaction [are] the top instructional processes identified by instructors and students" (Dixson, 2010, p. 2). Research concludes that

active learning improves content retention, addresses misconceptions, and increases student engagement and course satisfaction (Clary & Wandersee, 2010; Pundak, Herscovitz, & Shacham, 2010; Smith & Cardaciotto, 2011; Smith et al., 2009).

Summary

According to research, the most effective synchronous distance learning courses would include interaction and in-class engagement (Karal et al., 2010). The ability for active learning to promote interaction amongst students and instructors as well as improve learning seems to meld easily with a synchronous distance learning environment. The model promotes the climate of engagement recommended by the National Science Foundation (Smith et al., 2009), as well as increases content retention, addresses misconceptions, and improves student satisfaction in class.

Although there is little research on best practices in teaching in synchronous environments, there are indications that such a study would be beneficial to the educational community. It is time for best practices in synchronous distance learning to be revealed.

Intervention / Innovation

Upon reviewing the research, it is believed that active learning would be an appropriate pedagogical strategy to address these issues. Therefore, the innovation will be the addition of active learning activities within current DLN lessons. For this

action research project, active learning activities were added to the lesson "The Scientific Method: An Investigation on Impact Craters". Activities include "think-pair-share" partner discussion and individual writing activities, and both will be supported by large group discussions. The lesson follows a step-by-step process of working through the scientific method, with each step having dedicated time for large group discussion and checking for understanding. The steps are illustrated on a Power Point slide that is included throughout the lesson (see figure 3):

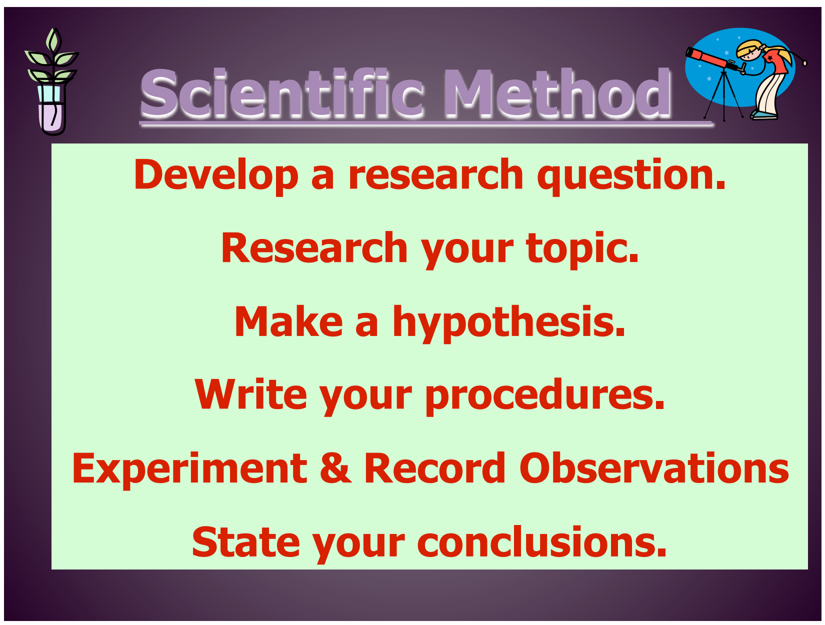

Figure 3: PowerPoint slide from "The Scientific Method: An Investigation of Impact Craters"

The "think-pair-share" activity will be used during discussion of the steps of scientific method as well methods of performing research for an experiment. At the beginning of instruction, the researcher will ask students to brainstorm steps that they already know of the scientific method, and will prompt each step of the active learning activity. The same will be done later during the lesson when the scientific

method step of performing research will be discussed. The researcher will ask students to brainstorm methods in which to perform research, and will prompt the students on each step of "think-pair-share".

Writing activities will be incorporated into the hypothesis and conclusion steps of the group experiment. Writing has already been a staple activity of the lesson, with students writing their hypotheses and conclusions on a worksheet in addition to observations made during the viewing of the experiment videos (see Appendix B). The worksheet is available for all teachers to download from the event catalog page at the Digital Learning Network website. After a large group discussion on the overview of writing an hypothesis and conclusion, these writing activities will be given specific time limits by the researcher during instruction: 1 minute for writing a hypothesis, and two minutes for writing a conclusion, and will be followed by large group discussions.

Membership of the Action Research Group

Students between 4th and 6th grades who participate in NASA's Digital Learning Network lesson, "The Scientific Method: An Investigation of Impact Craters", will be targeted to provide feedback on the active learning activities. Since the DLN reaches schools across the country, the socio-economic status of the participants may vary. However, it would be ideal to have students who have participated in a distance learning lesson prior to this lesson so they will be familiar with the learning environment. For this survey, 22 fourth graders from an elementary school in North Carolina, all of whom had previous experience in

distance learning classes, participated in the DLN lesson and submitted completed surveys.

Negotiations to Be Undertaken

In order to conduct an ethically appropriate research project, important parties will be contacted. The DLN project manager will be notified that this activity will be taking place. The management for the DLN encourages its education specialists to exhibit best practices in their teaching, so projects such as this will be welcomed. In order to obtain student responses, the teachers of participating classes will be asked via email for their cooperation in sharing the survey with their students after their participation. It will be noted in the said email that the student responses will be anonymous, and the results will be destroyed upon completion of the project.

Timeline

Phase 1 (January – March): identify are of focus; review literature; develop research questions; identify initial idea; notify DLN management of project

Phase 2 (Week of March 12): execute initial idea; contact teacher(s) for permission in distributing data collection tool to students; collect data.

Phase 3 (March-April): review literature review; analyze data; describe findings; develop action plan.

Phase 4 (April 20-28): finalize action research project; present project to class.

Data Collection and Analysis

In reviewing the literature, active learning is found to be a possible best practice for synchronous distance learning due to its emphasis on student engagement and learner-centered activities. For this action research project, a lesson on the scientific method taught via NASA's Digital Learning Network has been modified to include examples of active learning. The activities include "think-pair-share", individual writing, and group discussions. These activities will be presented to a class without their prior knowledge in order to secure valid and undiluted data.

To collect the data, methodological triangulation will be utilized. After completing the lesson, will students provide their feedback through a 10-question survey distributed via www.surveymonkey.com that addresses the research questions (see Appendix A). The questions will collect both qualitative and quantitative data. After the lesson, students will answer both open-ended questions on their engagement, understanding of the content, and the active learning activities. In addition, students will provide their feedback by ranking the active learning activities according to a given scale. The scale will model a Likert scale, with each response having an assigned point value, 1 representing the lowest or most negative response, and 5 representing the highest or most positive response:

1: I did not learn anything

2: I learned a little

3: Neutral

4: I learned some new information

5: I learned a lot of new information

The first question on the survey will ask whether or not the student had experience with distance learning classes prior to the DLN lesson. As mentioned earlier, it will be preferred that the students have prior experience because they will be familiar with the learning environment and possible issues common with videoconferencing. This data will assist in internal generalizability, thus validating the collection of data as a whole. For the qualitative data, themes outlined by the research questions will be identified, and the students' written responses will be coded accordingly. Feedback from students will be referenced by the label "(S#)". For the quantitative data, the frequency of responses will be analyzed, and the measure of central tendency will be calculated in the form of the mean. The following equation will be used:

$$\text{Mean} = \frac{\text{sum of scores}}{\text{number of score}}$$

$$(\bar{x}) = \frac{\Sigma x}{n}$$

Both sets of data will be cross-referenced and connected to themes revealed in the literature review.

In order to answer subquestion A, "how will using the active learning model affect the knowledge retention of science content with 4th grade students", data will be analyzed from two open-ended questions:

> Q3: List 3 (three) things you learned about the scientific method after participating in today's lesson.
>
> Q10: Please share any additional comments.

In order to answer subquestion B, "how will using the active learning model address misconceptions and gaps in 4th grade students' understanding of science content", data will be analyzed from one open-ended and three scaled questions:

Q2: What did you know about the scientific method before today's class?

Q7: Today's lesson helped me understand the process of the scientific method.

Q8: Today's lesson helped me understand how to write a hypothesis.

Q9: Today's lesson helped me understand how to write a conclusion.

In order to answer subquestion C, "how will the active learning model increase student engagement during the synchronous distance learning class", data will be analyzed from three open-ended questions:

Q4: Did you enjoy today's think-pair-share activity? Why or why not?

Q5: Did you enjoy today's the writing activities for creating the hypothesis and conclusion? Why or why not?

Q6: Overall, did you enjoy this lesson? Why or why not?

Findings

Upon reviewing the data of the 22 completed surveys, the themes of student engagement, knowledge retention-scientific method, knowledge retention-other information, and misconceptions and gaps were revealed.

How will using the active learning model affect the knowledge retention of science content with 4th grade students?

The data culled for this question was overwhelming positive. While many of the students listed facts they learned about impact craters and reported what happened in the experiment in addition to information they learned about the scientific method, the results supported research that stated active learning improve content retention (Clary and Wandersee, 2010; Pundak, Herscovitz, & Shacham, 2010; Smith & Cardacitto, 2011; Smith et al., 2009):

Knowledge retention-scientific method

> 1) Learned what a hypothesis was 2) Learned about the mass of a golf ball, baseball and a marble 3) Learned about craters and how they have rays and ejecta around them. (S2)
>
> The steps for completing the scientific method. That hyponosis [sic] means a guess. Finally the part of seeing a crater between the Baseball, Golf Ball, and the Marble. (S7)

Knowledge retention-other information

> I learned that when a meteor hits the white rocks go under the red rocks. Another thing I learned is that a village in Germany built [sic] their house's on the crator [sic]. Finally I learned that when a meteor hit's [sic] it open's [sic] like a flower. (S1)
>
> Three things I learned were how craters were made, that different hights [sic] made the marble go deeper and we learned what the small mountains inside the craters are called. (S9)

It was quickly revealed that the students entered the DLN class with large gaps in their understanding of the scientific method. When asked to recite their prior knowledge in the survey, several students responded with "nothing".

Misconceptions and gaps

> I really didn't know that much about the scientific method before the class. But I learned something [sic] new in that class. (S6)
>
> No I did not know anything about what I learned there. I didn't even know what a scientific method was but now I know because of you. (S5)

The resulting data for students' opinions on the effectiveness of specific parts of the lesson were positive indicators that the active learning activities were effective. Students were asked to score on the Likert scale their opinion on how the lesson assisted them in understanding the process of the scientific method. Of the 22 responses, 12 felt that they had learned a lot of information, 7 felt that they had learned some new information, none had neutral opinions, 3 students felt they had learned little information, and none believed they had learned no information.

	I did not learn anything 1	2	3	4	I learned a lot of new information 5
Number of Responses	0(0%)	3(13.6%)	0(0%)	7(31.8%)	12(54.5%)

The following descriptive statistics were used to describe the distribution of the students' responses:

2, 2, 2, 4, 4, 4, 4, 4, 4, 4, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5

$$\text{Mean } (\bar{x}) = \frac{\Sigma x}{n}$$

$$= \frac{94}{22}$$

$$= 4.27$$

Mode = 5.0 (most frequently occurring score)

Median = 5.0 (the middle score in this distribution of 22 responses)

Standard Deviation = 1.03

The writing activities used for the hypothesis and conclusion instruction were interspersed through the lesson, and were followed by large group discussions as illustrated by Figure 2 (Smith et al., 2009). Students were asked to score their opinion on how the lesson helped their understanding on how to write a hypothesis. Of the 22 responses, 10 felt they had learned a lot of information, 8 felt they had learned some new information, 2 had neutral opinions, 2 felt they learned little, and none believed they had learned no information.

	I did not learn anything 1	2	3	4	I learned a lot of new information 5
Number of Respondents	0(0%)	2(9.1%)	2(9.1%)	8(36.4%)	10(45.4%)

The following descriptive statistics were used to describe the distribution of the students' responses:

2, 2, 3, 3, 4, 4, 4, 4, 4, 4, 4, 4, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5

$$\text{Mean } (\bar{x}) = \frac{\Sigma x}{n}$$

$$= \frac{92}{22}$$

$$= 4.18$$

Mode = 5.0 (most frequently occurring score)

Median = 4.0 (the middle score in this distribution of 22 responses)

Standard Deviation = 0.96

As the research stated, active learning assists in addressing and clarifying any misconceptions or gaps (Clary and Wandersee, 2010; Pundak, Herscovitz, & Shacham, 2010; Smith & Cardacitto, 2011; Smith et al., 2009). With 54.5% and 45.4% of students stating that they learned a lot of information on the scientific method and how to write a hypothesis respectively, the students' gaps in knowledge on the scientific method had been effectively addressed. Therefore, the active learning activities had a positive affect on addressing misconceptions and gaps.

Students were asked to score their opinion on how the lesson helped their understanding on how to write a conclusion. Of the 22 responses, 7 felt they had learned a lot of information, 4 felt they had learned some new information, 4 held neutral opinions, 6 felt they had learned little information, and 1 felt they had learned no information.

	I did not learn anything 1	2	3	4	I learned a lot of new information 5
Number of Respondents	1(4.5%)	6(27.3%)	4(18.2%)	4(18.2%)	7(31.8%)

The following descriptive statistics were used to describe the distribution of the students' responses:

1, 2, 2, 2, 2, 2, 2, 3, 3, 3, 3, 4, 4, 4, 4, 5, 5, 5, 5, 5, 5, 5

$$\text{Mean } (\bar{x}) = \frac{\Sigma x}{n}$$

$$= \frac{76}{22}$$

= 3.45

Mode = 5.0 (most frequently occurring score)

Median = 3.0 (the middle score in this distribution of 22 responses)

Standard Deviation = 1.34

It was noted that there were a significant number of lower scores for the conclusion activity (see Figure 4).

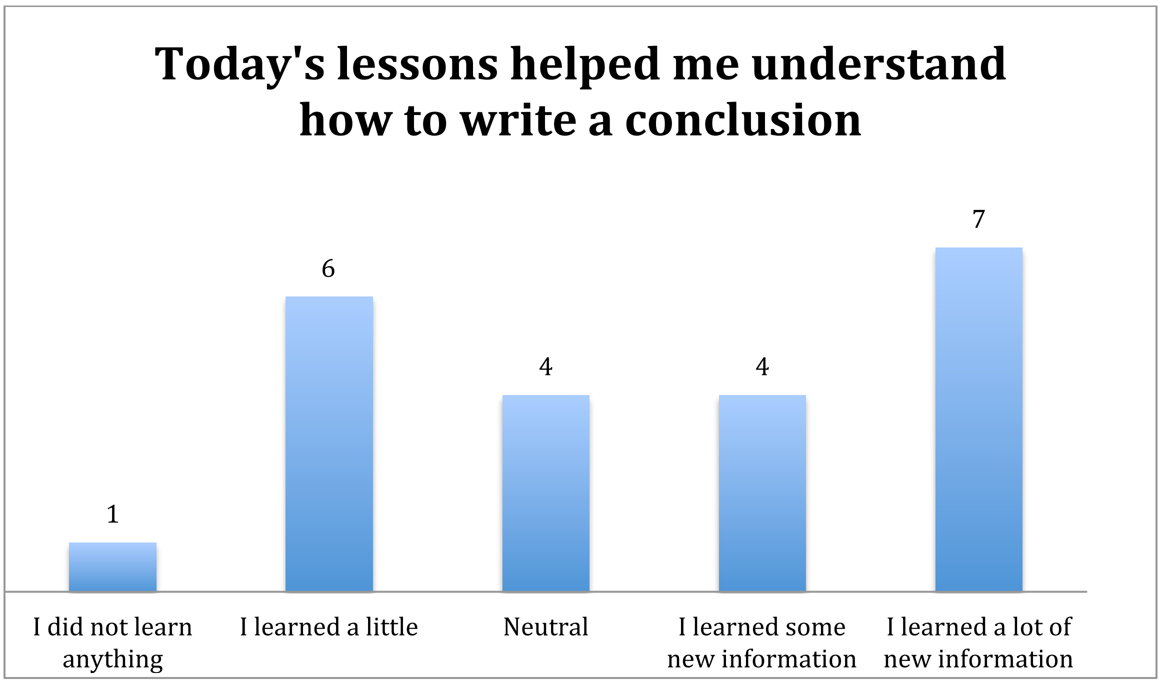

Figure 4: Table results of Q9

This activity occurred toward the end of the lesson, during which instruction time was running short. Wickersham and McGee (2008) remarked that the pace and flow of instruction was critical to having learners achieve the course objectives. As the instruction time ran short, the pace and flow of instruction was interrupted and the students had limited time to complete the activity. Unfortunately, the result

was that their misconceptions and gaps in understanding of how to write a conclusion were not addressed. It was never clearly determined whether the two-minute time limit for writing a conclusion was sufficient for the students during the action research. It was revealed that the time limit for the hypothesis might not have been long enough:

Misconceptions and gaps

> I did not enjoy writing a hypothesis because I did not get what to do. I was trying to figure out what to write but when I did 1 minute was all over and I couldn't write anymore because I needed to pay attention to what I was learning so I did not miss anything of the really cool and important details about craters. (S13)

Since this piece of data revealed that the student's understanding in how to write a hypothesis was negatively impacted by the writing time limit, it would be advantageous to study the effects of changing the time period allowed for this and the conclusion phase in the instruction in the future.

How will the active learning model increase student engagement during the synchronous distance learning class?

Student engagement materialized in a variety of ways during the lesson: personal enjoyment, drawing connections to class curriculum, and learner motivation. In general students enjoyed the "think-pair-share" activities while learning about research and steps in the scientific method because the activity allowed them to interact with their peers.

Student engagement

> I enjoyed the pair-share activity because I got to talk to friends and learn at the same time. Kids love fun and to learn so I think it was a good idea to mix fun with learning! (S1)

> I really did like it because I like to be participating in everything I can. This helped me to understand it more. It also helped me to focus and not start into space. (S7)

The data was in accordance with Dixson's (2010) observation that collaboration and dynamic interaction between students were a few of the top instructional processes in distance learning that successfully engage students.

Smith and Cardacitto's (2011) and Smith, Douglas, and Cox's (2009) conclusions that active learning techniques provide students opportunities to utilize higher order thinking skills such as synthesis were illustrated by the data, as well. Students revealed that the collaboration activity assisted them in not only understanding the content in the lesson, but also to make connections to content they were learning in class.

Student engagement

> I did. I did because it helps us with what we are learning in class right now so it also helped us with ELA [english/language arts]. (S16)

Learner motivation was also revealed in the data. When asked for their thoughts on how they enjoyed the writing activities for the hypothesis and conclusion, students gave high praise because the activities allowed them to think like scientists.

Student engagement

> I did like the hypothesis because I was really a scientist. (S17)

> Yes I did because we got to take an educated guess and I hoped my guess would be right. I liked doing this because we got to do what siencetest [sic] do. (S14)

Although students reported that the abstract extrinsic motivators used by the instructor, such as humor and other communication methods, successfully engaged them and increased their personal enjoyment of the lesson, a few students reported having negative reactions to the writing activities.

> No, because I don't like writing. (S15)
>
> No because it was a little boring. (S11)

Research has explored how the relationship between students and teachers can be built through engaging interaction, thus enriching learner motivation (Azaira, 2011; Coppola, 2002). However, as represented by the examples, when the student lacks intrinsic motivation or has a negative perception of an activity, student engagement can be affected. The influence of intrinsic motivators in distance learning was not explored for the action research; this area of motivation would be an intriguing next step to take in future studies.

In its entirety, the exploration of student engagement, knowledge retention, and misconceptions and gaps drew interesting conclusions in the action research (see Figure 5).

Figure 5: Concept map of action research themes

Most of data collected supported the research thus far, and revealed interesting points to study in the next stages of the project. The high quantitative scores supported the positive written feedback, and illustrated the positive effect active learning had in a synchronous distance learning environment. Therefore, active learning would be an effective teaching method for synchronous distance learning.

Action Planning

This action research found that active learning serves as a promising effective teaching method for synchronous distance learning environments.

It was originally planned to present the modified DLN lesson to more than one fourth-grade class from the North Carolina school. However, as often happens in education, teacher schedules were changed and the rest of the fourth grade classes did not connect for the DLN lesson. Therefore, the usability and effectiveness of the active learning strategies need to be tested with more classes. It is planned to continue this study at the start of the 2012-2013 school year and administer the survey to several more classes.

As mentioned in the findings, the collected data revealed an interesting influence on learner motivation – intrinsic motivation. Although this was not studied for the action research project, it would be an intriguing area to explore in the upcoming stages of the project. Exploration would include reviewing literature on how motivators affect student engagement, and developing data collection tools that address the topic.

It would also be advantageous to study the affect increasing the given writing time for the hypothesis and conclusion has on addressing misconceptions and gaps in knowledge. As the data revealed, the students felt that they did not fully understand how to write a hypothesis and conclusion. This may have been due to the limited amount of instruction time remaining, so it is planned to adjust the time for both writing activities in the next research cycle.

In addition to collecting more data, it would be beneficial to present these results to the fellow Digital Learning Network education specialists. Despite being located at centers across the country, all of the specialists for the Digital Learning Network aim to present the highest quality of content using the most effective methods. Professional development sessions are held bi-monthly throughout the year to sharpen skills and learn new education strategies, and this action research would certainly be appropriate to present at one of these sessions.

This project served as a fascinating look into synchronous distance learning and how instructional techniques can affect learning. It is planned to continue to implement active learning techniques with the DLN lesson on the scientific method, and apply active learning to several more DLN lessons in the future.

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Appendix A. Post-lesson survey administered via www.surveymonkey.com

The Scientific Method: An Investigation on Impact Craters Lesson Survey

Exit this survey

1. Have you participated in a distance learning class before?

Yes

No

2. What did you know about the scientific method before today's class?

3. List 3 (three) things you learned about the scientific method after participating in today's lesson:

4. Did you enjoy today's think-pair-share activity? Why or why not?

5. Did you enjoy the writing activities for creating a hypothesis and conclusion? Why or why not?

6. Overall, did you enjoy this lesson? Why or why not?

7. Today's lesson helped me understand the process of the scientific method.

	I did not learn anything	I learned a little	Neutral	I learned some new information	I learned a lot of new information
The scientific method	○	○	○	○	○

8. Today's lesson helped me understand how to write a hypothesis.

	I did not learn anything	I learned a little	Neutral	I learned some new information	I learned a lot of new information
How to write a hypothesis	○	○	○	○	○

9. Today's lesson helped me understand how to write a conclusion.

	I did not learn anything	I learned a little	Neutral	I learned some new information	I learned a lot of new information
How to write a conclusion	○	○	○	○	○

10. Please share any additional comments

Done

Appendix B. *The Scientific Method: An Investigation of Impact Craters* Student Worksheet

Experiment Data Sheet

	Hypothesis		30 cm drop	60 cm drop	90 cm drop
Object 1 - Marble		Marble Mass:			
		Crater Diameter:			
		Length of Ray:			
Object 2 – Golf Ball		Golf Ball Mass:			
		Crater Diameter:			
		Length of Ray:			
Object 3 - Baseball		Baseball Mass:			
		Crater Diameter:			
		Length of Ray:			

Conclusion Statement: